## TABLE OF CONTENTS

	Page
ABSTRACT	I
ACKNOWLEDGEMENT	IV
TABLE OF CONTENTS	VI
LIST OF TABLES	XII
LIST OF FIGURES	XV
CHAPTER ONE	
INTRODUCTION	1
CHAPTER TWO	
LITERATURE REVIEW	
2.1 Milk and its constituents	. 5
2.1.1 General composition of milk	5
2.1.1.1 Fat	. 6
2.1.1.2 Proteins	7
2.1.1.3 Lactose	9
2.1.1.4 Ash/mineral matter	10
2.1.1.5 Minor constituents of milk	10
2.2 Food value of milk	11
2.3 Food value of other dairy products	12
2.3.1 Butter	12
2.3.2 Cheese	12
2.3.3 Ice cream	1.2

2.3.4 Concentrated milks	13
2.3.5 Skim milk	13
2.3.6 Fermented milks	13
2.4 Processing and preservation of milk	. 14
2.4.1 Heat preservation or processing	15
2.4.1.1 Sterilization	15
2.4.1.2 Pasteurization	16
2.4.1.2.1 Definition of pasteurization	17
2.4.1.2.2 Methods of pasteurization	17
2.4.1.2.3 In bottle pasteurization	18
2.4.1.2.4 Equipment for pasteurization	18
2.4.1.2.5 Advantages of HTST pasteurization	22
2.4.1.3 Thermization	23
2.4.1.4 Ultra high temperature (UHT) treatment	23
2.4.1.5 Ultra pasteurization	24
2.4.1.6 Factors affecting the shelf life of heat treated milk	24
2.4.1.7 Quality control of heat-treated milk	24
2.4.1.7.1 Pasteurized milk	24
2.4.1.7.2 UHT milk	25
2.4.1.7.3 Sterilized milk	25
2.4.2 Cold preservation of milk and milk products	26
2.4.2.1 Freezing	26
2.4.2.2 Chilling/refrigeration	` 26

## VIII

2.4.3 Preservation by fermentation	27
2.4.4 Activation of inhibitory systems in milk	27
2.4.5 Addition of a preservative	27
2.4.5.1 Mechanism of effects	. 27
2.5 Importance of clean raw milk for processing	28
2.6 Clean milk production	29
2.6.1 Summery of important steps in the procedure of clean milk	
production from healthy cows using manual milking	30
2.7 Microbiology of milk and milk products	31
2.7.1 Sources of contamination of milk	31
2.7.2 Requirement for microbial growth	32
2.7.3 Types of microorganisms associated with milk	34
2.8 Shelf life of foods	38
2.8.1 Major modes of food deterioration	38
2.8.2 Importance of shelf life	38
CHAPTER THREE	
MATERIALS AND METHODS	
3.1 Location	40
EXPERIMENT 01	
3.2 Analysis of raw milk	40
3.2.1 Chemical analysis	40
3.2.1.1 Sampling procedure	40
3.2.1.2 Fat %	` 40

3.2.1.3 Solid Non Fat %	41
3.2.1.4 Lactose %	41
3.2.1.5 Acidity %	43
3.2.1.6 pH	. 43
3.2.2 Microbiological analysis	44
3.2.2.1 Sampling procedure	44
3.2.2.2 Sterilization of glassware and other equipment	
3.2.2.3 Preparation of microbiological media	44
3.2.2.4 Sterilization of media and Ringer's Solution	45
3.2.2.5 Preparation of dilution series	46
3.2.2.6 Inoculation	46
3.2.2.7 Incubation	46
3.2.2.8 Counting	47
3.2.2.9 Methylene Blue Dye Reduction Time	. 47
EXPERIMENT 02	
3.3 Determination of optimum temperature-time combination	
for HTST pasteurization of milk	48
3.3.1 Calibration of the feed pump of the pasteurizer	48
3.3.2 Cleaning and sanitizing of the pasteurizer	49
3.3.3 Pasteurization of milk	49
3.3.4 Chemical Analysis	50
3.3.5 Testing for effectiveness of pasteurization	50
3.3.6 Homogenization Index	`51

3.3.7 Sensory evaluation	
EXPERIMENT 03	
3.4 Determination of level of CO <sub>2</sub> that can be added below sensory	
threshold limit	. 52
3.4.1 Pasteurization and bottling of milk	52
3.4.2 Incorporation of CO <sub>2</sub>	52
3.4.3 Determination of level of CO <sub>2</sub> dissolved in milk	53
3.4.4 Determination of sensory threshold level of added CO <sub>2</sub>	53
EXPERIMENT 04	
3.5 Determination of suitable combination of CO <sub>2</sub> level and	
temperature-time treatment to get optimum product quality	
and maximum shelf life	54
EXPERIMENT 05	
3.6 Effect of dissolved CO <sub>2</sub> on the keeping quality of raw milk	55
3.7 Experimental design and data analysis	55
CHAPTER FOUR	
RESULTS AND DISCUSSION	
4.1 Chemical and microbiological analysis of raw milk	56
4.1.1. Chemical analysis	56
4.1.2 Microbiological analysis	57
4.2 Determination of optimum temperature- time combination	
that gives best sensory qualities	60
4.3 Determination of sensory threshold level of CO <sub>2</sub> added in to	
pasteurized milk	62

4.4 Effect of temperature-time combination and CO <sub>2</sub> addition	
on chemical parameters, microbiological quality and	
shelf life of chilled pasteurized milk	64
4.4.1 Changes of chemical parameters	. 64
4.4.1.1 Effect of dissolved CO <sub>2</sub> and temperature-time combination	
on mean pH of pasteurized milk	64
4.4.1.2 Effect of dissolved CO <sub>2</sub> and temperature-time	
combination on mean acidity (lactic acid %) of pasteurized milk	66
4.4.2 Changes of microbiological quality	68
4.4.2.1 Effect of dissolved CO <sub>2</sub> and temperature-time combination	
on mean VPC of pasteurized milk	68
4.4.2.2 Effect of dissolved CO <sub>2</sub> and temperature-time combination	
on mean thermoduric count of pasteurized milk	71
4.4.2.3 Effect of dissolved CO <sub>2</sub> and temperature-time combination	
on mean psychrotrophic count of pasteurized milk	74
4.5 Effect of dissolved CO <sub>2</sub> on the keeping quality of raw milk	78
CHAPTER FIVE	
CONCLUSION	85
REFERENCES	86-88

## LIST OF TABLES

		Page
Table 01	Principal fatty acids found in milk triglycerides	7
Table 02	Effect of temperature on the growth of bacteria in milk	
	produced under different conditions	29
Table 03	Water activity values for selected groups of microorganisms	34
Table 4.1	Chemical analysis of raw milk	56
Table 4.2	Microbial counts of raw milk	57
Table 4.3	Effect of temperature-time combination on sensory	
	attributes of pasteurized milk	60
Table 4.4	The best-estimated threshold of CO <sub>2</sub> (ASTM E-679	
	Ascending Series Concentration Method of Limits)	62
Table 4.5	Effect of dissolved CO <sub>2</sub> and temperature-time combination	
	on mean pH of pasteurized milk during 21 days of storage at 4 $^{0}\mathrm{C}$	65
Table 4.6	Effect of dissolved CO <sub>2</sub> and temperature-time combination	
	on mean acidity (lactic acid %) of pasteurized milk during 21	
	days of storage at 4 $^{0}$ C	67
Table 4.7	Effect of dissolved CO <sub>2</sub> and temperature-time combination	
	on mean VPC (log cfu/ml) of pasteurized milk during 21 days	
	of storage at 4 $^{0}$ C	69
Table 4.8	Effect of dissolved CO <sub>2</sub> and temperature-time combination	
•	on mean thermoduric count (log cfu/ml) of pasteurized milk	
	during 21 days of storage at 4 <sup>0</sup> C	72

Table 4.9	Effect of dissolved CO <sub>2</sub> and temperature-time combination	
	on mean psychrotrophic count (log cfu/ml) of pasteurized milk	
	during 21 days of storage at 4 °C	75
Table 4.10	Effect of temperature-time combination and CO <sub>2</sub> addition on	
	the duration of reaching the maximum allowable VPC	77
Table 4.11	Effect of dissolved CO <sub>2</sub> on mean VPC (log cfu/ml) of raw milk	
	during 5 days of storage period at 4 °C	78
Table 4.12	Effect of dissolved CO <sub>2</sub> on mean thermoduric count (log cfu/ml) o	$\mathbf{f}$
	raw milk during 5 days of storage period at 4 $^{0}$ C	79
Table 4.13	Effect of dissolved CO <sub>2</sub> on mean psychrotrophic count (log cfu/ml	)
	of raw milk during 5 days of storage period at 4 °C	80
Table 4.14	Effect of dissolved CO <sub>2</sub> on mean coliform count (log cfu/ml) of	
	raw milk during 5 days of storage period at 4 $^{0}$ C	81
Table 4.15	Effect of dissolved CO <sub>2</sub> on the mean pH of	
	raw milk during 5 days of storage period at 4 <sup>0</sup> C	82
Table 4.16	Effect of dissolved CO <sub>2</sub> on the mean acidity (lactic acid %) of	
	raw milk during 5 days of storage period at 4 <sup>0</sup> C	83